American Kuhne Develops Automatic Concentricity Adjustment

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Producers of precision medical tubing used in medical device applications are confronted with very stringent product quality and process capability requirements. The requirements cover physical properties of final tubing such as burst strength, elongation and lubricity. Medical tubing must also be free from surface quality imperfections such as gels, knit lines and melt fracture (rough surface finish). While most of these requirements can be controlled with proper process parameters, tooling design and clean product contact surface finishes, they cannot necessarily be controlled in a closed-loop fashion. The final tubing dimensions such as outside diameter, wall thickness and concentricity must also comply with the specification of the tube. Fortunately with the use of diameter and wall thickness measurement control systems, the diameter and average wall thickness are often automatically controlled. For instance, the diameter of the tube can be controlled by automatically adjusting air pressure in the die and the average wall thickness can be controlled by automatically adjusting the puller (haul-off) speed. This leaves concentricity as the dimension that is not controlled automatically.

Typical adjustable centre crosshead die heads that are used for small medical applications incorporate four die adjustment bolts that are manually “fine-tuned” to adjust concentricity of the tubing to avoid thin and thick sides of the tubing cross section. In many cases an on-line ultrasonic gauge is used for displaying real-time tubing wall thickness and concentricity. The majority of the manual concentricity adjustments occur during “set-up” operations. This procedure can be very time consuming and is difficult to repeat. Over time, as tubing is being produced, it is often the case that the die centre needs to be manually adjusted to compensate for uncontrolled variables such as die buildup.

American Kuhne has leveraged the die centring technology previously developed by their partner US blow moulding engineering firm Graham Engineering under patent number 5,674,440 for parison side wall adjustment on blow moulding machines. It has successfully implemented automatic die centring technology for small medical tubing applications. In fact, American Kuhne will develop the Graham Engineering technology a step further and incorporate closed-loop control of tubing wall thickness concentricity. This technology will be showcased in a live demonstration at the upcoming MD&M East Exposition in Philadelphia on June 18-20, 2013.

American Kuhne’s new die centring technology allows for automatic die centring for uniform wall thickness distribution for both inline die heads and crossheads. The new development includes a fixed centre die head, trademarked by the company as AK-u-Tube Fixed Center (Figure 1). AK-u-Tube is used to eliminate manual die centring and instead the die pin centre location relative to the die bushing is precisely adjusted by touchscreen control of four die pin heaters. These heaters are located in the mandrel of the die head where they can be heated in an uneven pattern to “flex” the die pin to control its position. The pattern will then expand the mandrel on one side and move the die pin stem and pin accordingly.

An adjustment system, trademarked by American Kuhne as the AK-U-Center Adjustment system, is integrated with an on-line ultrasonic gauge for full closed-loop control of concentricity. This involves capturing the data from the gauge controller and executing an algorithm in the PLC to perform the process control. The operator has the ability to view graphically the current centring positions, make manual adjustments and control automatic operation. Once the line is running the operator merely has to flip a switch to bring the die to centre. (Figure 2).

This system has been successfully tested in American Kuhne’s laboratory both in manual and automatic closed-loop control modes running medical tubing from a Pebax resin. In one experiment with 50% die pin heater power on one side, a medical tube with a 0.13 mm (0.005 inch) concentric wall thickness changed to 0.05 mm (0.002 inch) wall thickness on one side and 0.23 mm (0.009 inch) wall thickness on the other side. This system has been developed as an alternative to traditional die centring methods which can be time consuming and difficult to repeat. By incorporating closed-loop control, the concentricity of the final product is automatically maintained, ensuring consistent quality and performance.
thickness on the other side. Concentricity changed from 100% to 25% in approximately one minute. Tip flexing has a very quick reaction to power inputs, but the control system is designed for stability and to react to longer term changes in concentricity so as not to over-react to short term gauge reading fluctuations which can be caused by air bubbles or tube location within the gauge-head.

<< The tube with a reasonably centred wall on the left and with partial power on one side of the tip on the right. >>

<< Figure 2: Screen shot from Touchscreen Control of Concentricity >>

Significant benefits can be realised with this technology such as reduced product changeover times by eliminating operator manual adjustment of die centring during set-up that can be time consuming and difficult to accurately reproduce. Improved product quality and process capability (Cpk) is also achieved during production by maintaining concentricity with automatic closed-loop control. These benefits will result in reduced start-up times, lower defect rates and improved overall process repeatability.

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